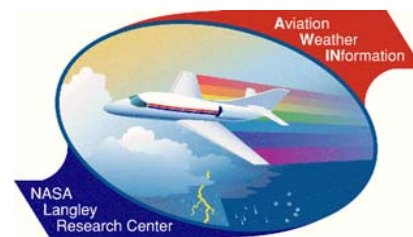


TAMDAR Capabilities Development

June 6, 2001



Taumi Daniels

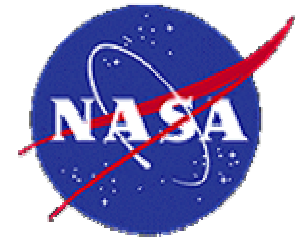
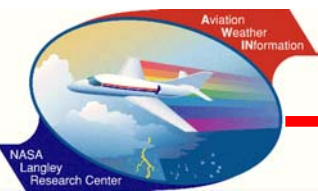
NASA Langley Research Center

Hampton, Virginia

(757) 864-4659

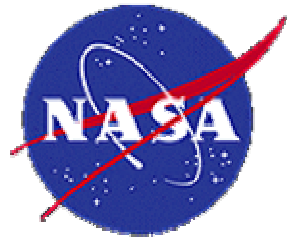
t.s.daniels@larc.nasa.gov

Outline



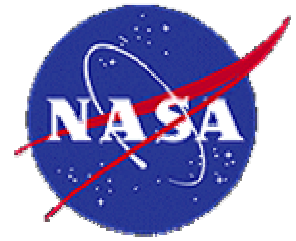
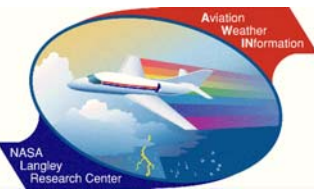
- Goal & Background
- TAMDAR Sensor Development & Testing
- Coverage Analysis
- Related FAA & NOAA Activities
- Fleet Operational Evaluation
- Alternate Method
- Summary

Goal of TAMDAR



"Demonstrate a TAMDAR system capability through a fleet evaluation in the NAS under a FAA, NOAA, NASA, and Industry joint effort."

TAMDAR Background

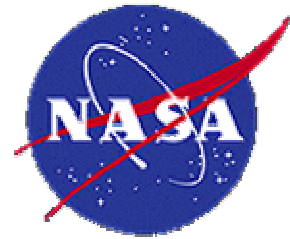
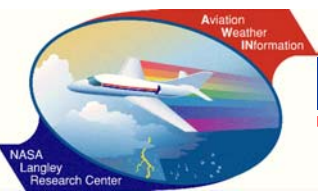


National Aviation Weather Program Council (Federal Coordinator for Meteorology, NASA, FAA, NTSB, NWS, DOD, Department of Agriculture)

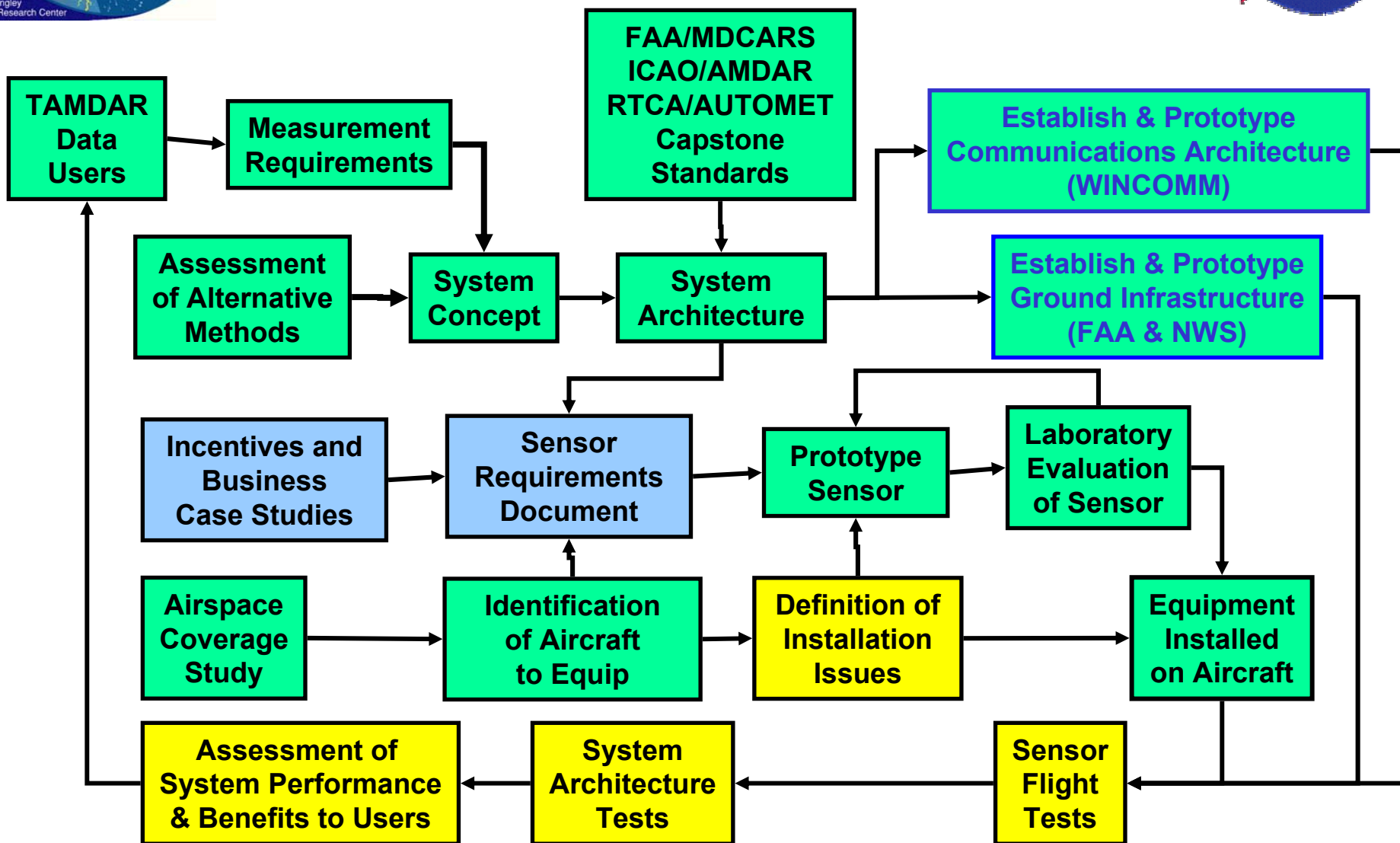
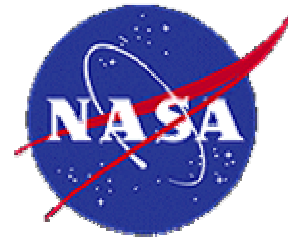
- National Aviation Weather Program Strategic Plan, April 1997
 - National Aviation Weather Initiatives, January 1999
-

- Implement data link capabilities for Flight Information Services (FIS)
- Develop and implement multifunctional color cockpit displays incorporating FIS products
- **Expand and institutionalize the generation, dissemination, and use of automated **PIREPS** to the full spectrum of the aviation community, including general aviation**
- Improve underlying weather forecasting services
- Require, develop, and implement aviation weather-related training packages for users
- Improve aviation weather information telecommunications capabilities for ground-ground dissemination of aviation weather products
- Establish objective standards for characterizing various weather phenomena for national and international use

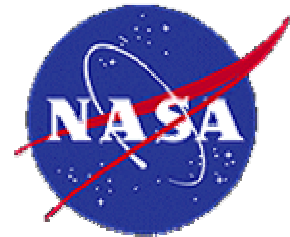
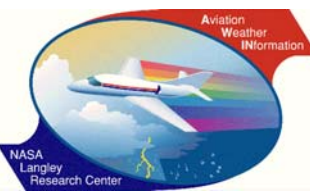
TAMDAR Background



- NavRadio Team Phase I CRA propose low cost electronic pilot report capability
- Transmitter design stymied by lack of frequency allocation; effort focused on sensor
- After many acquisitions, NavRadio ➡ Honeywell, Int.
- Phase II CRA not pursued by Honeywell, Int.
- Effort becomes project under AWIN
- Tri-Agency Team formed to develop concept of operations
- GTRI / ODS task contract in place to complete sensor development
- ARNAV Phase II CRA to deploy sensors and test data link



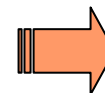
TAMDAR Sensor



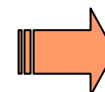
ODS Sensor

Icing
Temperature
Pressure Altitude
Humidity
Magnetic Heading
Eddy Dissipation Rate*
True Airspeed*
Dew point*
Density Altitude*
Winds at Altitude*

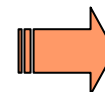
*can be computed



Cockpit Display



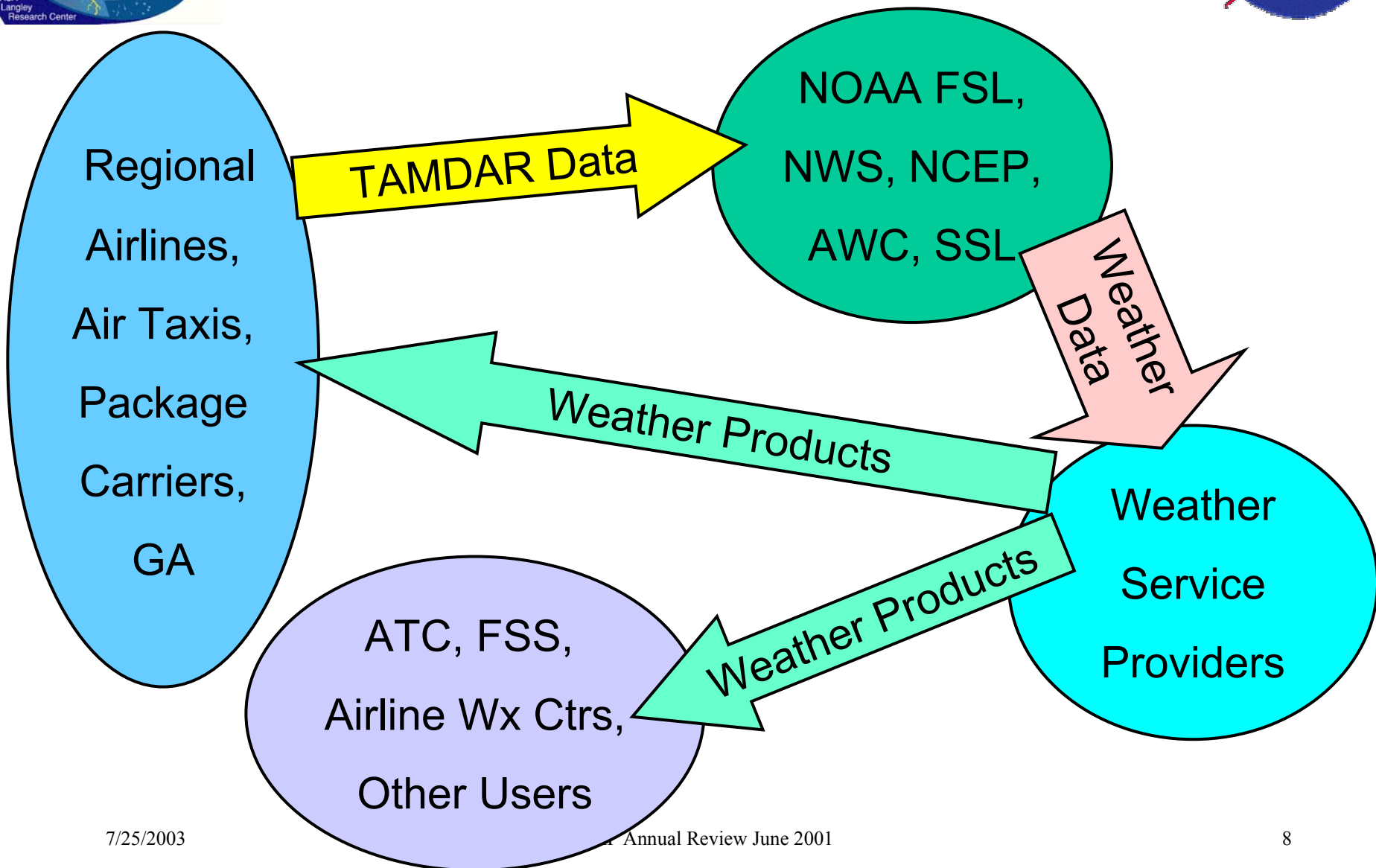
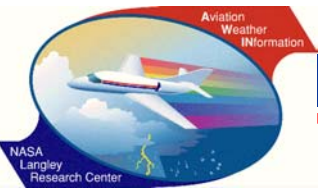
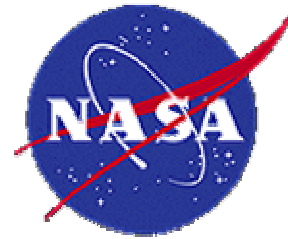
Ground Station



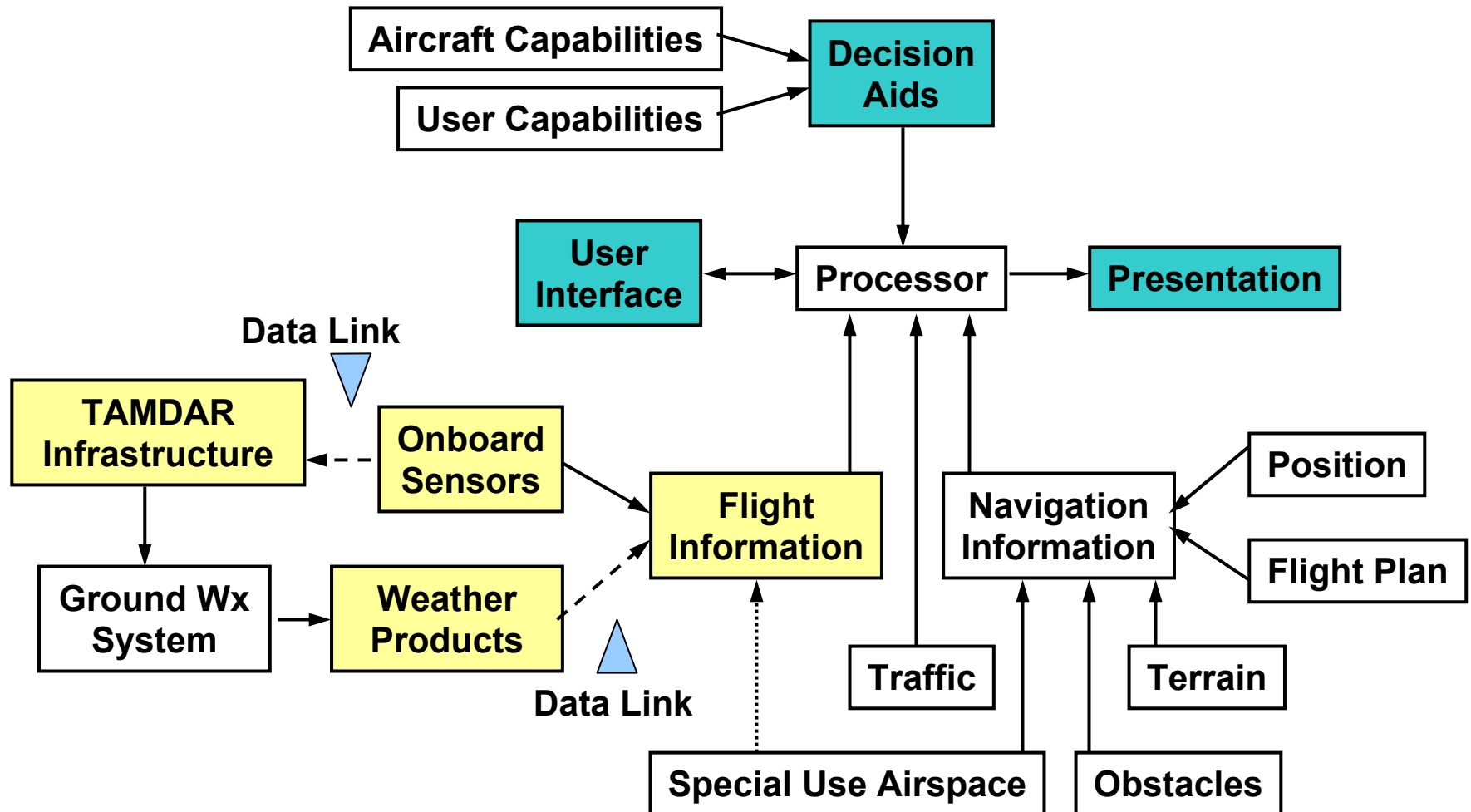
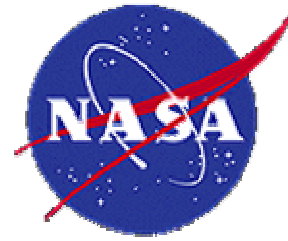
Other Aircraft

TAMDAR is envisioned to downlink weather data from non-jet aircraft. The weather data will be sent to FSL, FSS, ATC, AWC, and others via a ground-based infrastructure and to other aircraft. New weather products will be generated and uplinked to the cockpit.

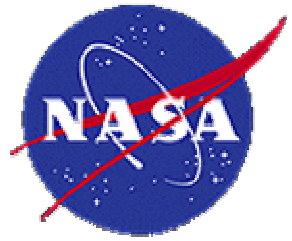
TAMDAR System Concept



AWIN System

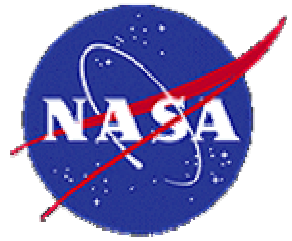


Sensor Development



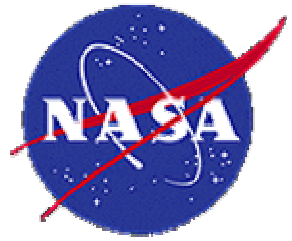
- Task Contract with GTRI and subcontractor ODS
- Subtask 1: Requirements Definition and Design Review
- Subtask 2: Sensor Fabrication
- Subtask 3: Flight test on research aircraft
- Future Tasks: Evaluate flight test results; make design modifications as needed, fabricate additional units; conduct fleet evaluation; evaluate results

Sensor Development



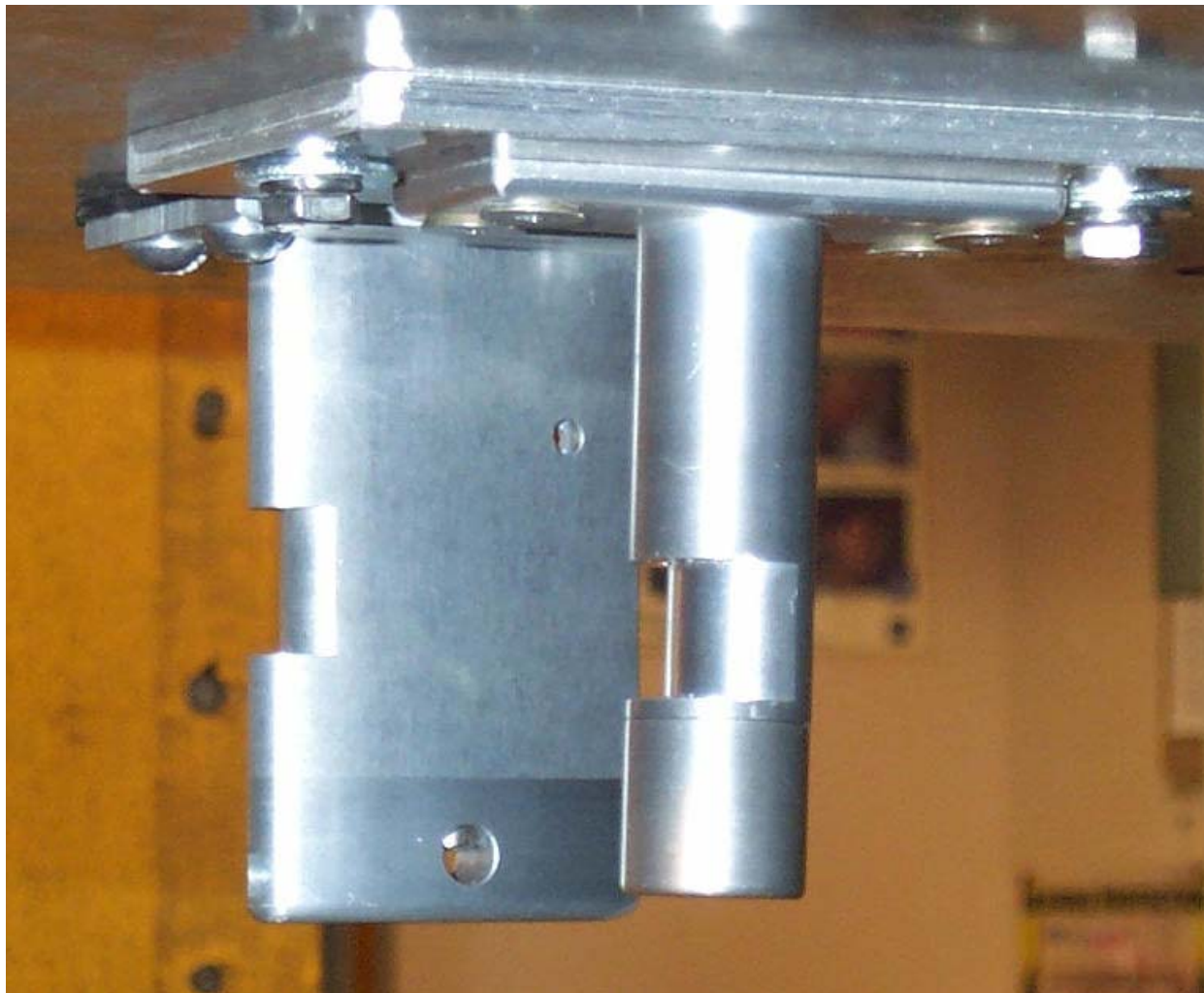
- Current version of sensor ground tested and flight tested
- Next version of sensor currently under development
- Flight test of next version planned for 10-11/01 on-board University of Wyoming B200 atmospheric research aircraft
- Possible flight testing during International Water Project (IHOP) 5-6/02

NASA Ground Tests



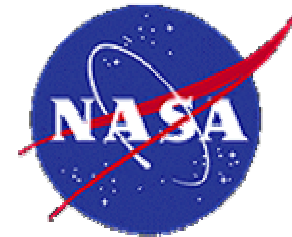
- Langley 7 x 10 Inch Low Speed Tunnel (5/2001 – 6/2001)
 - Air speed, temperature, pressure comparison
- Langley Test & Dynamics Branch Facilities
 - “Shake and Bake” testing includes temperature, pressure, and vibration
 - Testing to be conducted May – June 2001
- Glenn Icing Research Tunnel Test (3/21 – 3/23)
 - Piggyback on another test
 - ODS also tested Model 1000 Icing Sensor

NASA Ground Tests

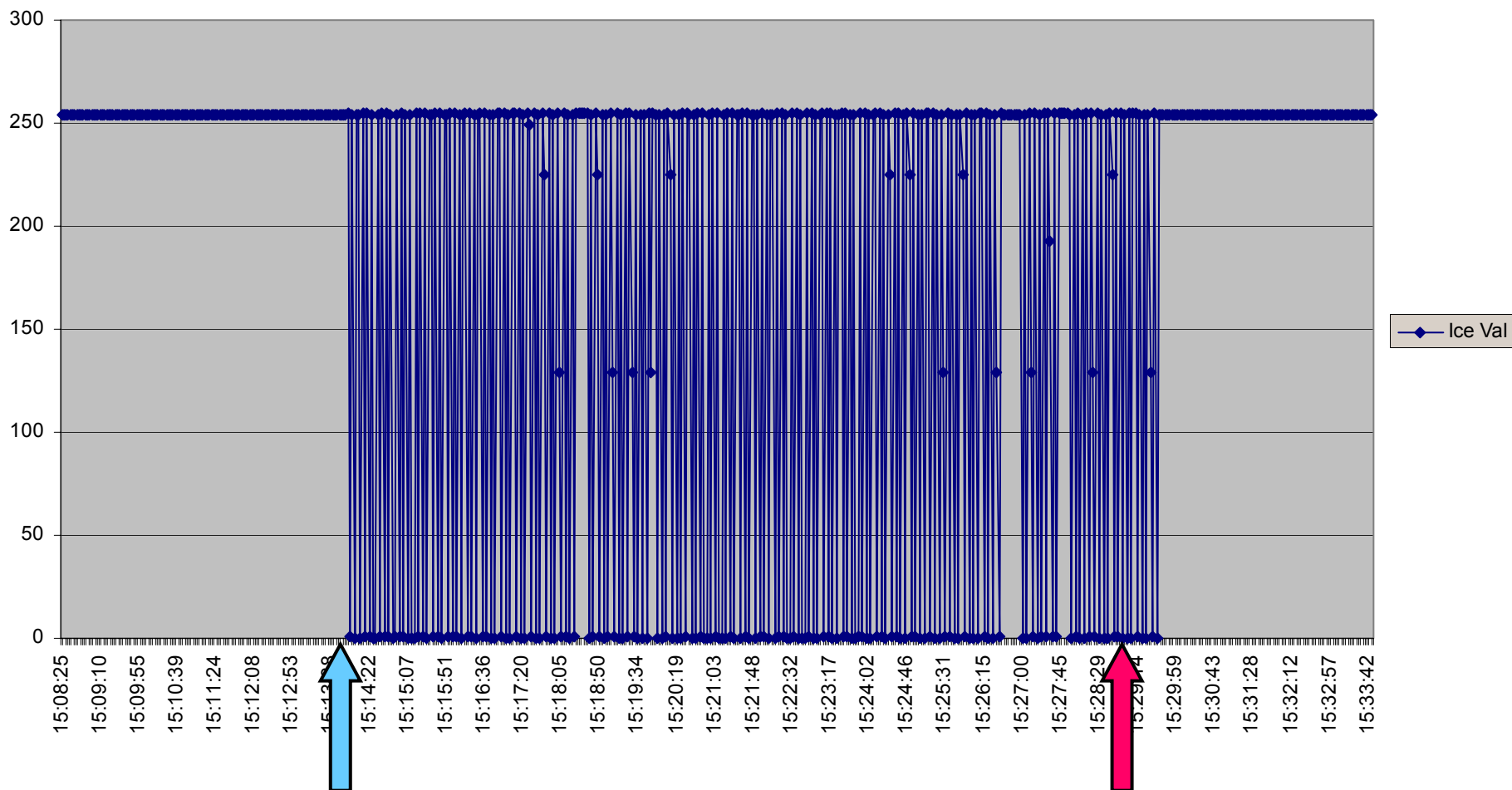




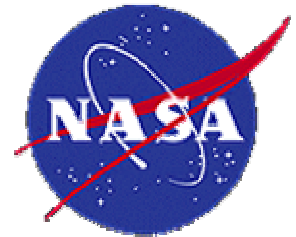
NASA Ground Tests



3/21 First Run Icing Response



NASA Ground Tests

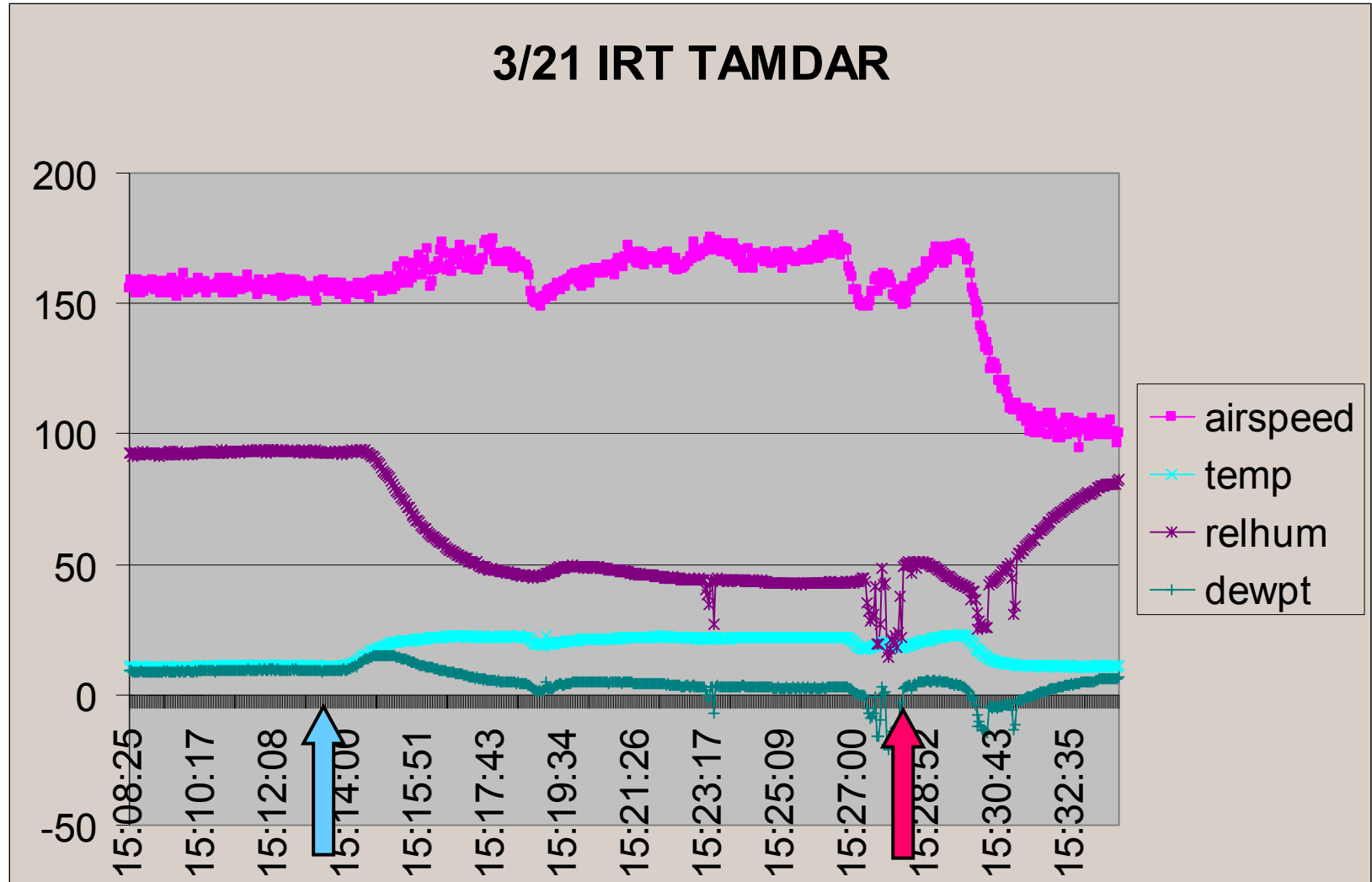
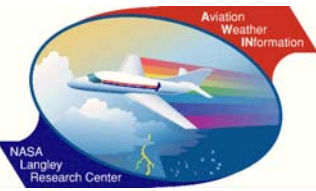
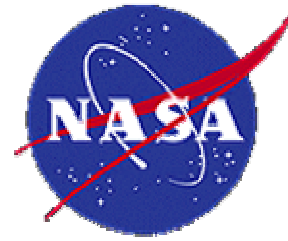


7/25/2003

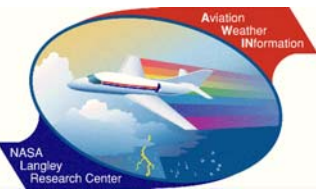
WxAP Annual Review June 2001

15

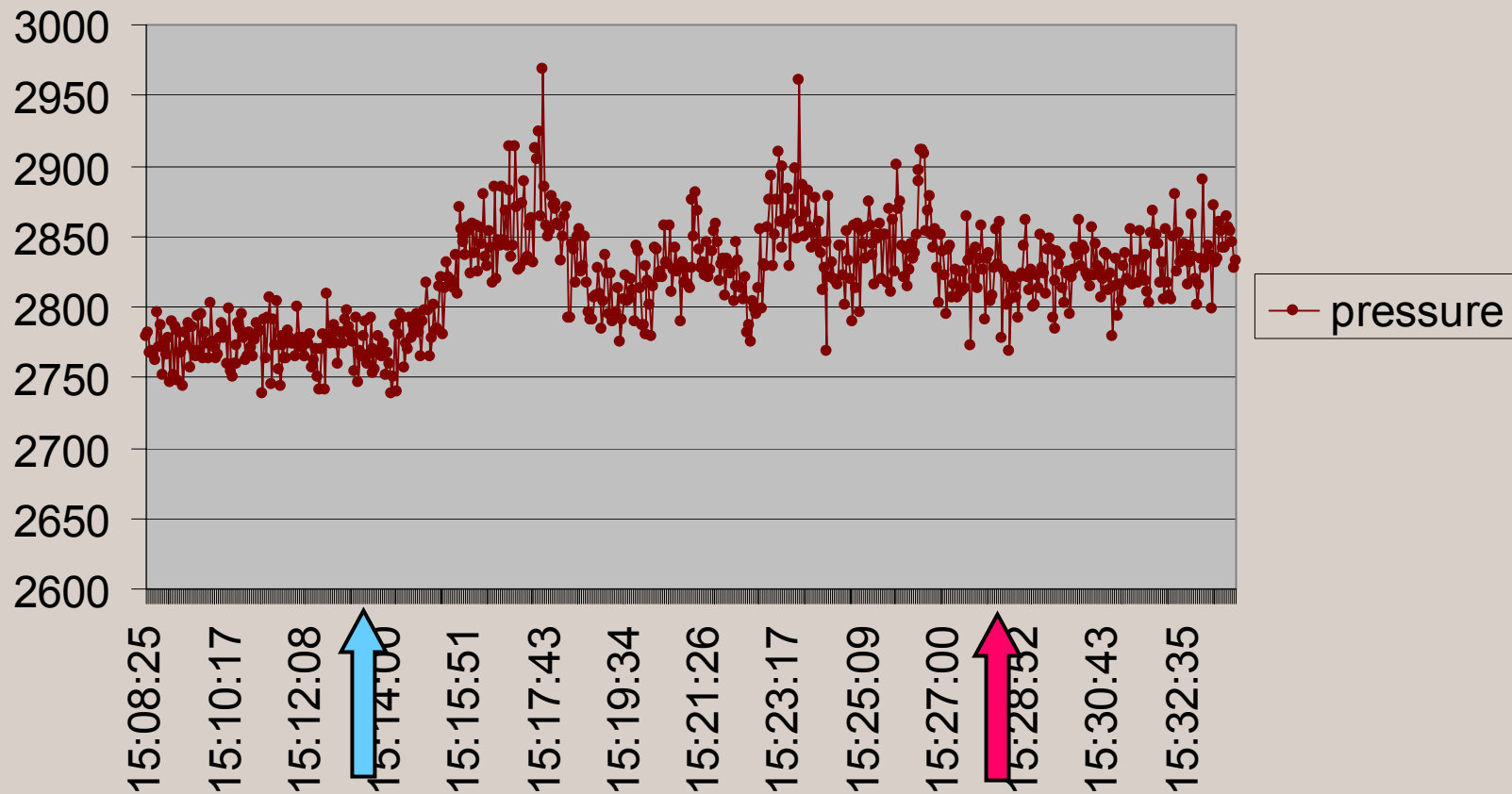
NASA Ground Tests



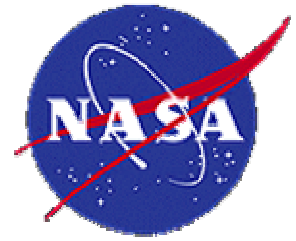
NASA Ground Tests



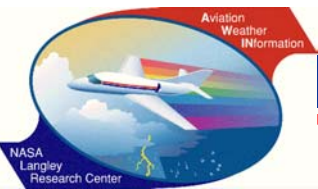
3/21 IRT TAMDAR



NASA Flight Test



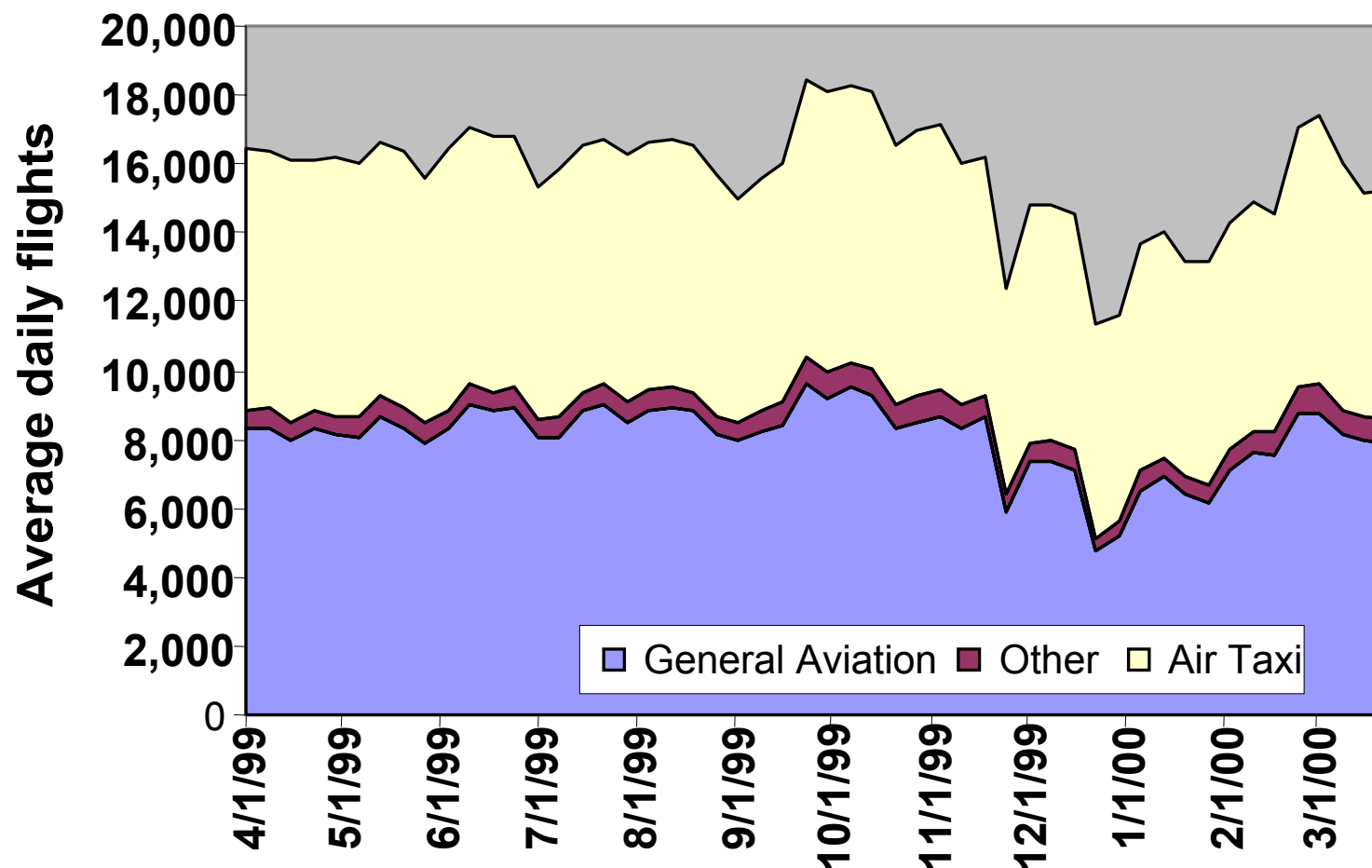
- Three flight test series scheduled, August – November 2001
- AWIN, WINCOMM coordination for data link testing
- Goal: To provide support to WINCOMM for TAMDAR system architecture tests (Cessna 206H)
- TAMDAR in support role, not central research effort



ETMS Analysis of IFR Flights



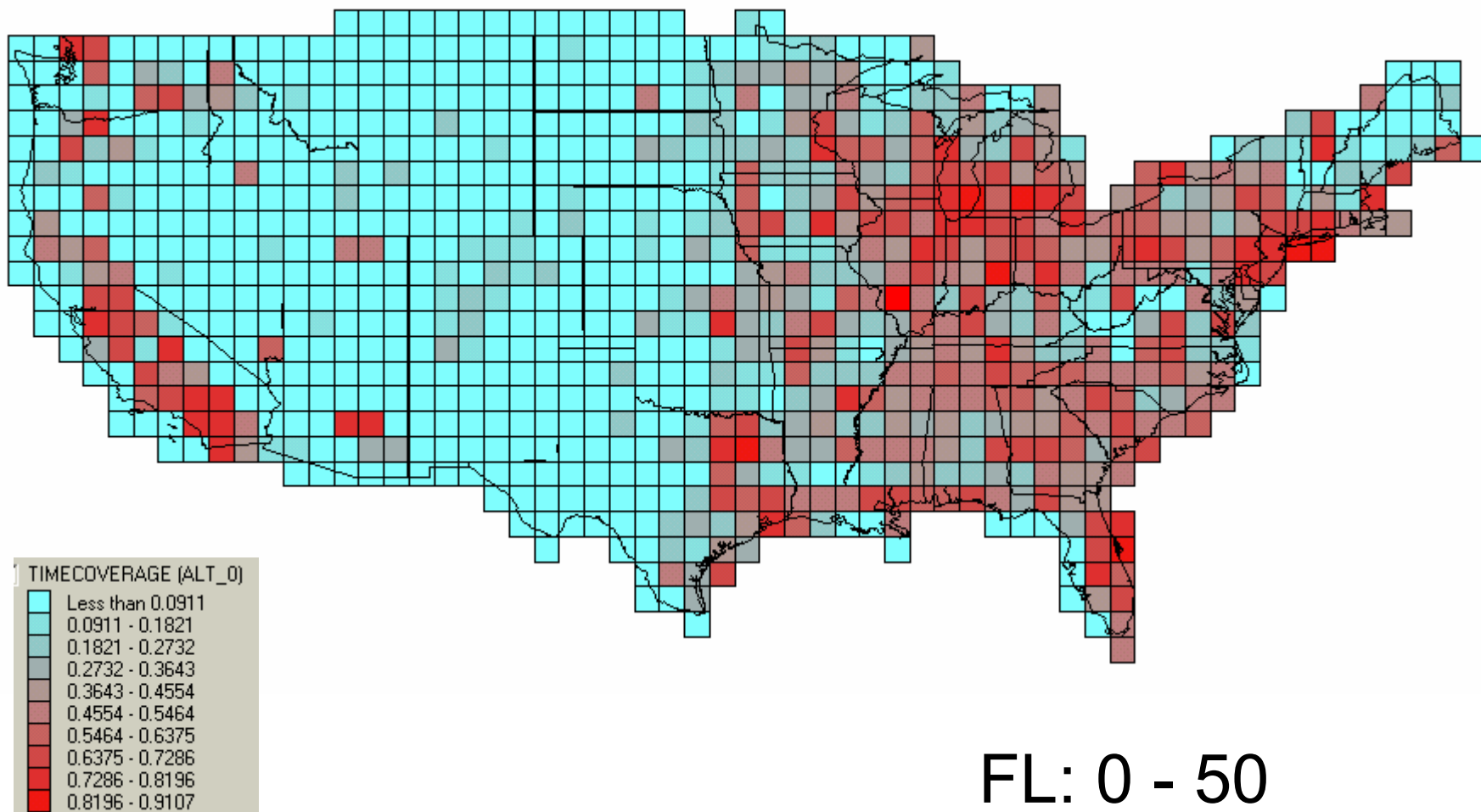
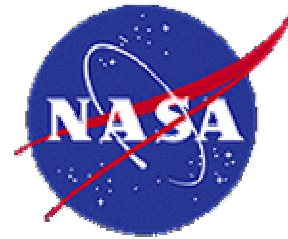
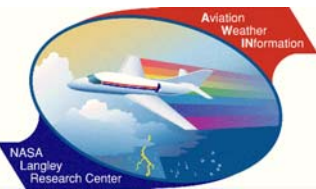
Average weekly operations over 12 months



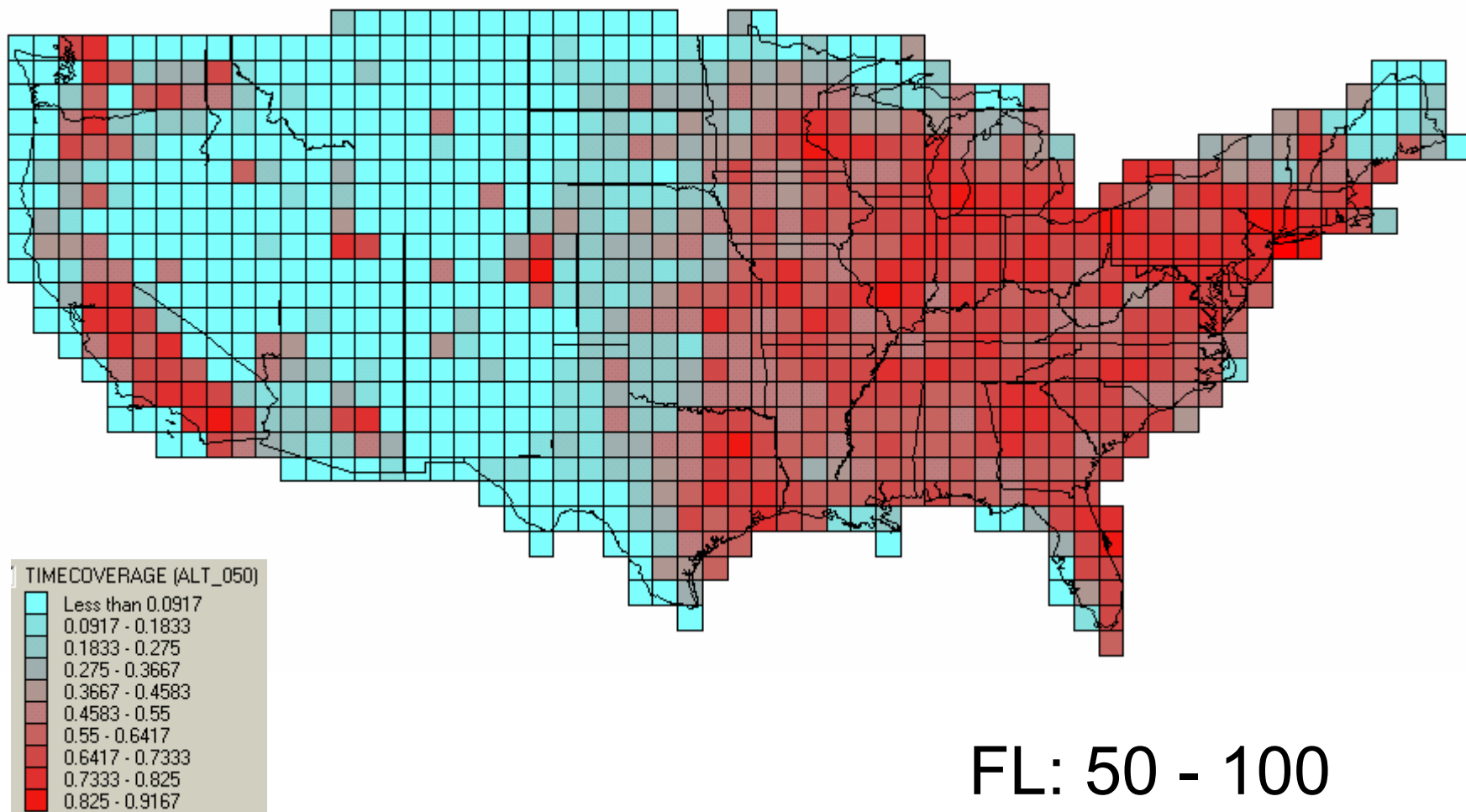
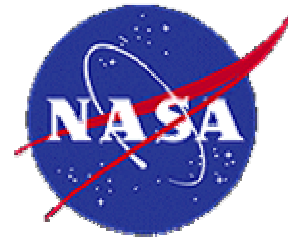
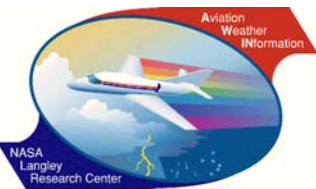
Many thanks to Nancy Kalinowski, ATA-2

Source: FAA ATA-200 AT Airspace Lab Brent Brunk

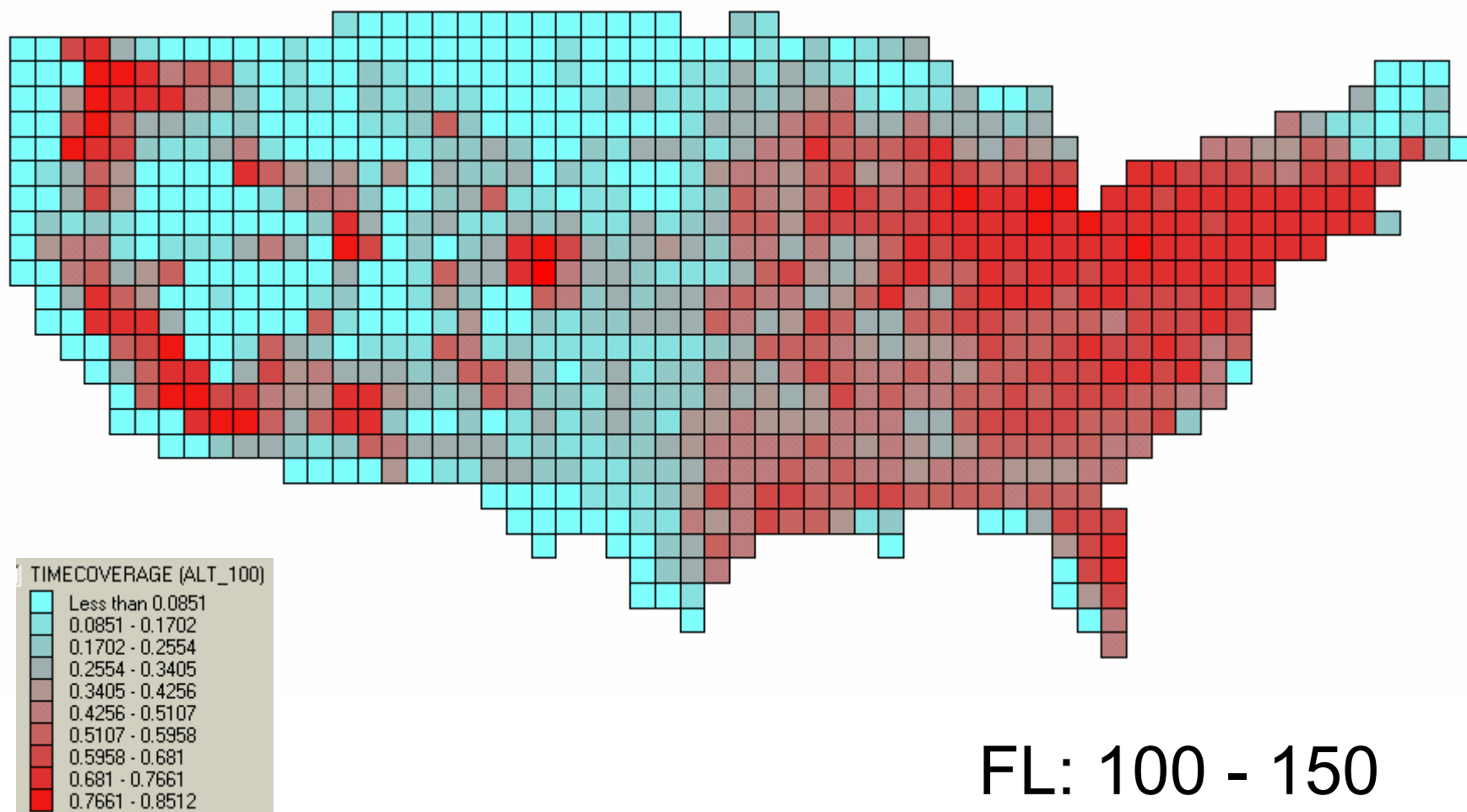
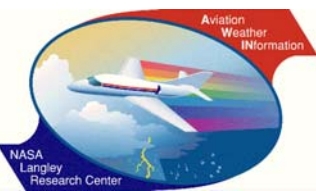
ETMS Analysis of IFR Flights



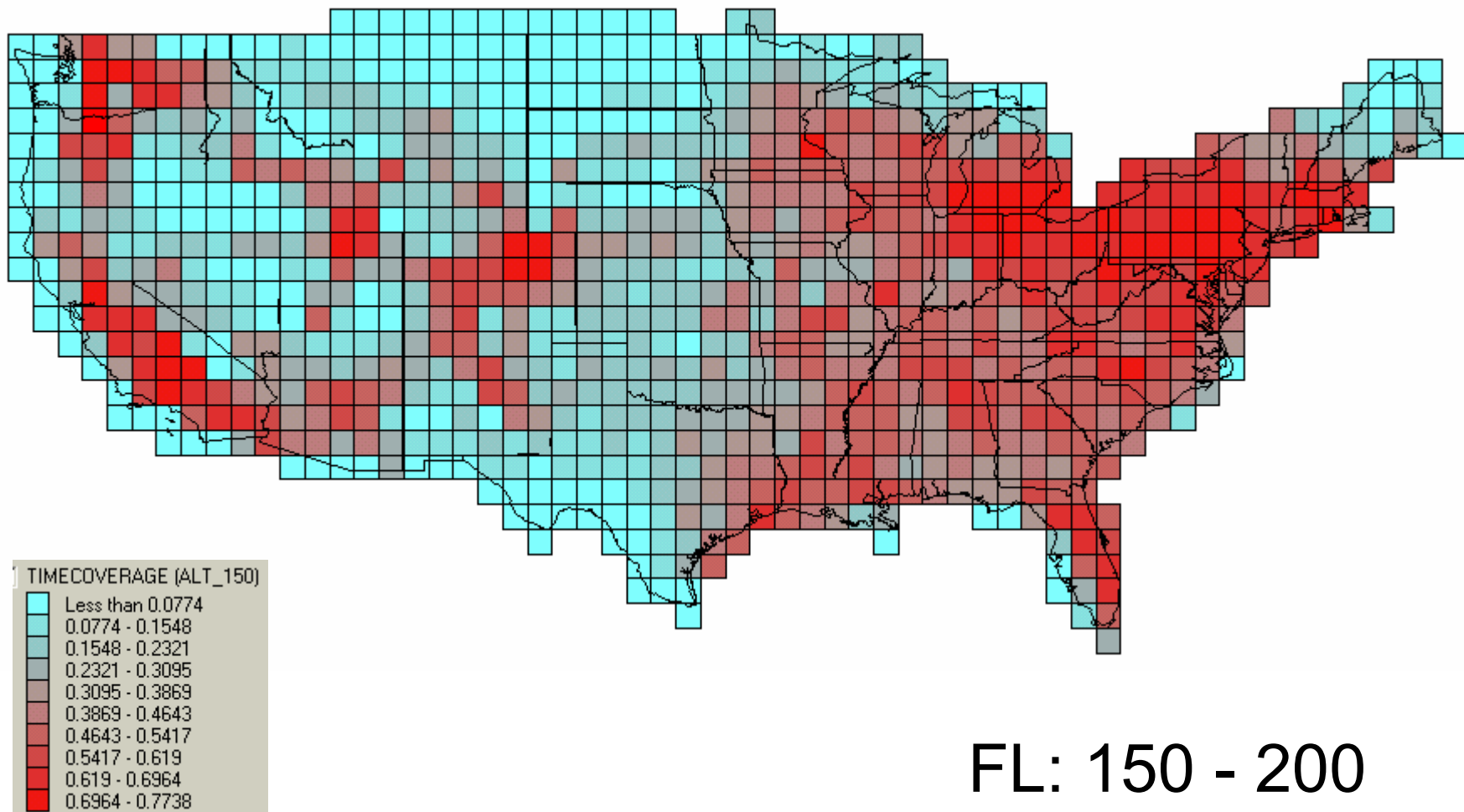
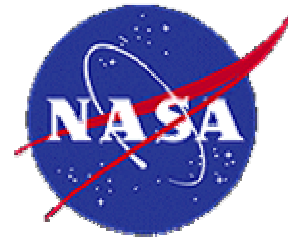
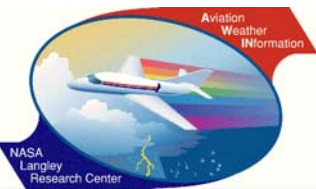
ETMS Analysis of IFR Flights



ETMS Analysis of IFR Flights



ETMS Analysis of IFR Flights

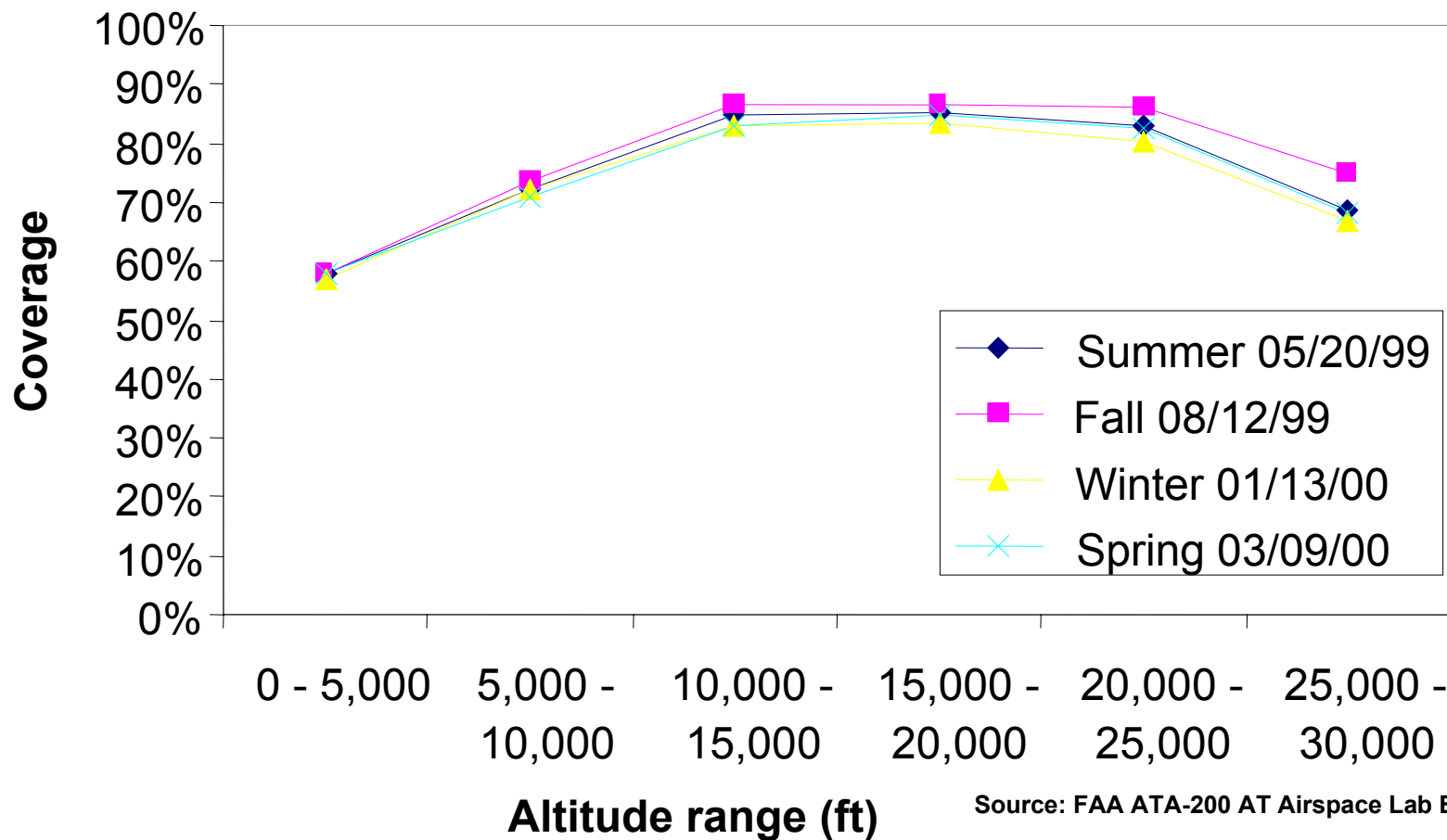




ETMS Analysis of IFR Flights

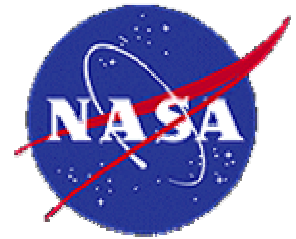
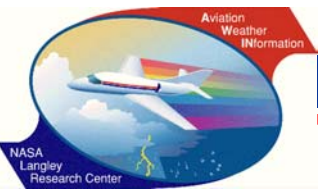


Estimated % CONUS Coverage of TAMDAR flights

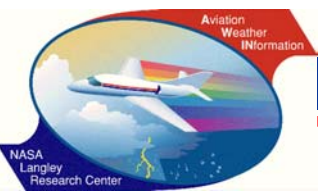


Source: FAA ATA-200 AT Airspace Lab Brent Brunk

Capstone and TAMDAR



- FAA Capstone agreed to AWIN proposal to include TAMDAR into Bethel Area operational evaluation
- NASA to deliver 10 certifiable sensors
- FAA Capstone to support equipage, certifications, installations, and modifications to communications infrastructure
- ODS to support installations and calibrations

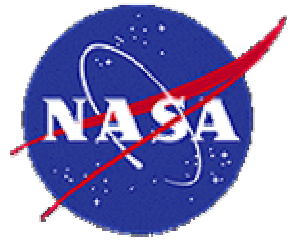


Tri-Agency TAMDAR Team



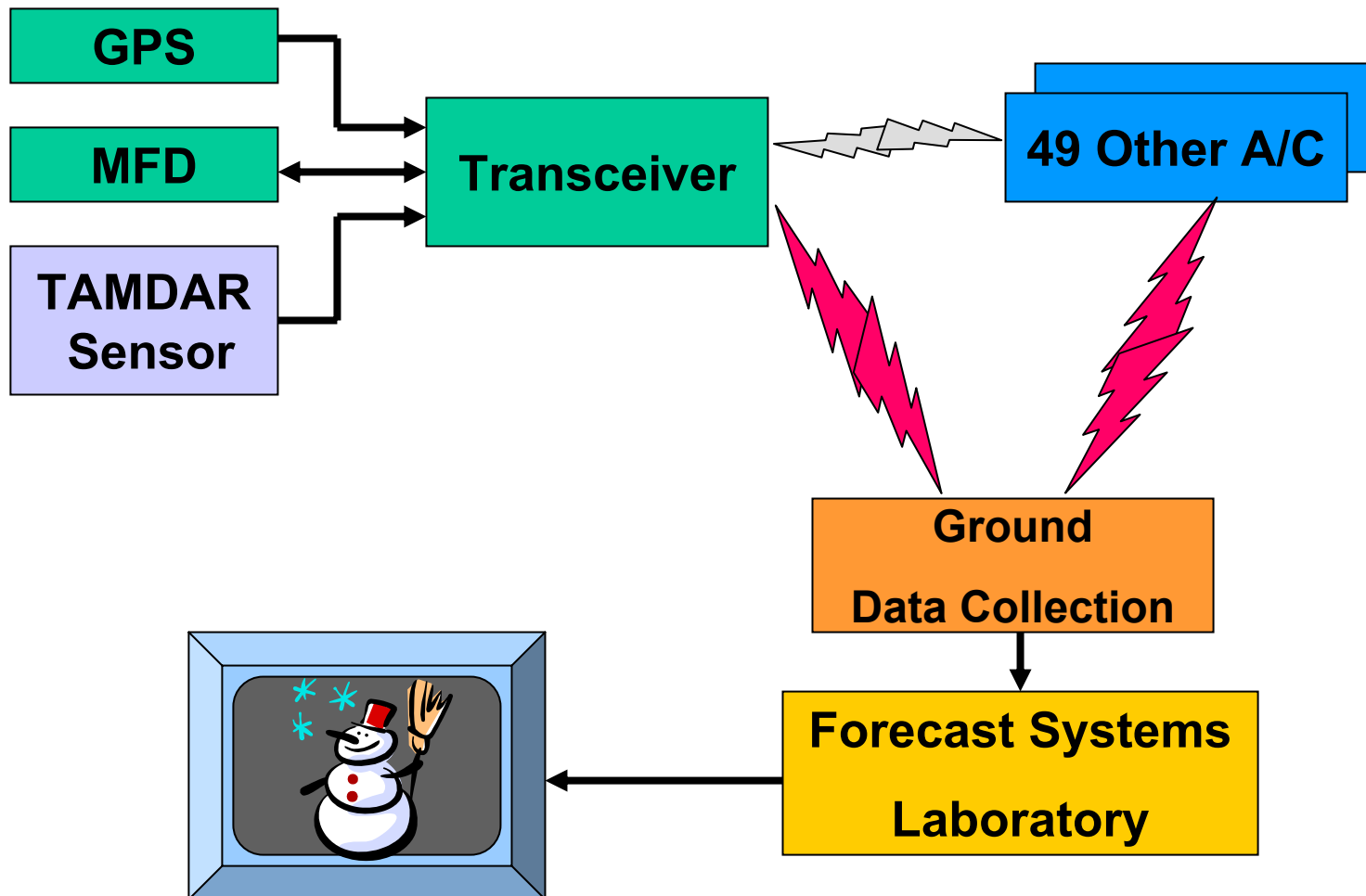
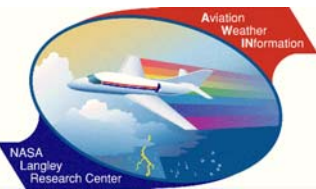
- Representatives from NASA Langley, NASA Glenn, FAA ARW-100, FAA AUA-400, NOAA FSL, NOAA NWS meet to coordinate activities related to TAMDAR
- First action: No longer use term “E-PIREP”
- Currently drafting “Concept of Operations”

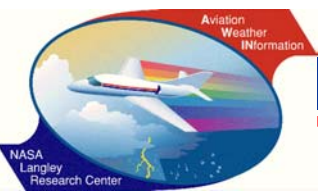
NOAA FSL Activities



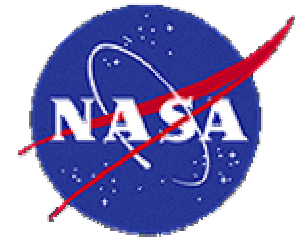
- Goal of Fleet Operational Evaluation is to get the data to NOAA Forecast Systems Lab
- Challenges for FSL:
 - Provide consultation on sensor development
 - Identify and establish sources of corroborative weather information
 - Perform data validation, collection, storage and archival
 - Investigate meteorological phenomena revealed by this new high resolution data
 - Develop new weather products

Fleet Operational Evaluation Concept



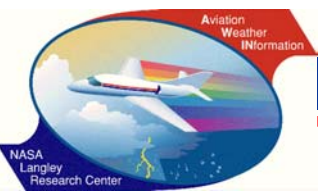


Candidate Communications Links

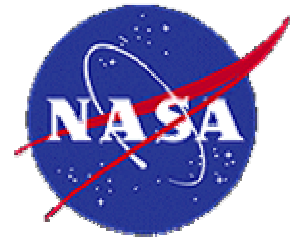


Disseminate data to NOAA FSL via one of the following:

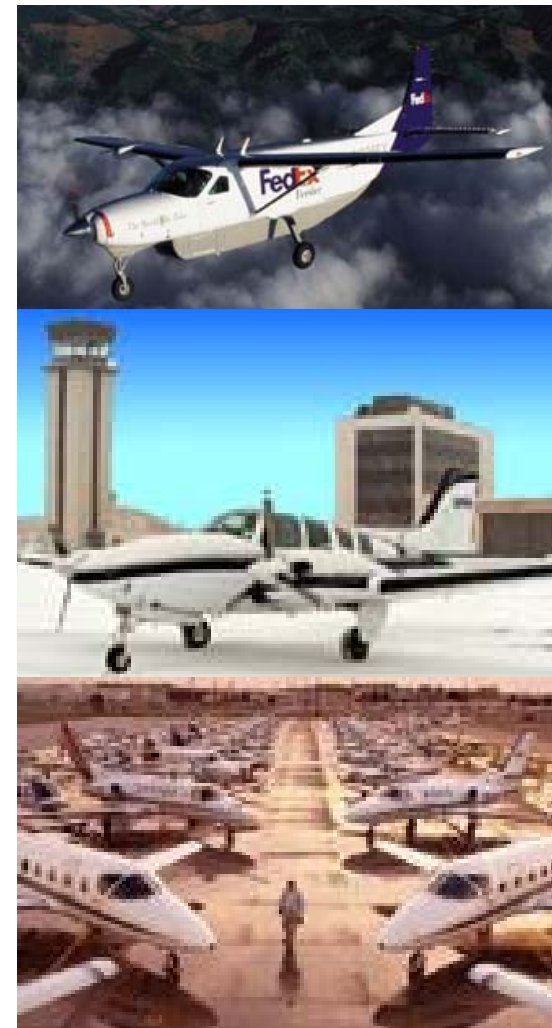
- ARNAV
- Honeywell
- UPS AT
- EchoFlight
- ARINC
- Cellular Modem
- FlyTimer
- Orbcomm
- SITA



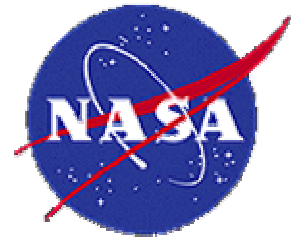
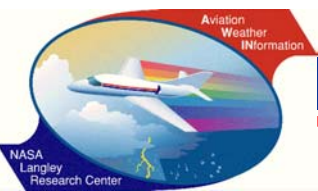
Fleet Operator Selection Criteria



- Two or more fleet operators
- At least 50 aircraft of same type
- 24 x 7 operations
- Extensive routes in geographically diverse regions
- Can be FIS & TAMDAR equipped
- Can participate in 6 month duration research project
- Candidates: UND, ERAU, OU, United Express, UPS, Federal Express

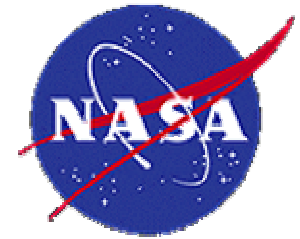


Calibration Issues



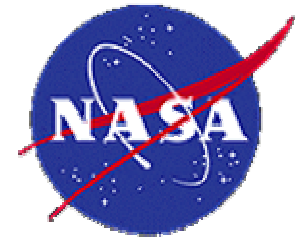
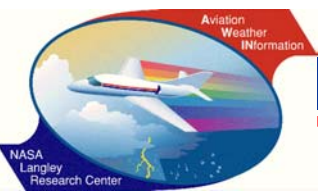
- Sensors are factory calibrated
- Capability to perform field calibration with external connection to instrumentation
- Possibly perform self-checking via ASOS or other sources via data link
- Ground truth checking at FSL
- Need to establish calibration schedule and standards
- Some pilot training may be involved

Certification for Fleet O. E.



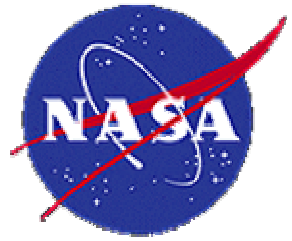
- Fleet Operational Evaluation would require:
 - FAA Certification of sensor
 - Selection of fleet operator and aircraft type
 - Certification Plan
 - RTCA DO-160E testing

National Demonstration



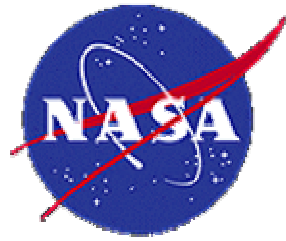
- AvSP goal for a 2002 National Demonstration
- Some Potential Activities Include:
 - Cessna 206H cross-country flight with data link
 - B200 King Air (NASA 8) flights with data link
 - International Water Vapor Experiment (IHOP) using University of Wyoming King Air with data link
 - Planned Fleet operational evaluation most likely to occur in 2003

Alternate Method



- NPOESS – National Polar Orbiting Operational Environmental Satellite System – DoD, NASA, NOAA team with partners EUMETSAT and NASDA
- 5 NPOESS satellites, deployed from 2008 to 2011, operational through 2018, each equipped with a subset of ten different sensors.
- ATMS – Advanced Technology Microwave Sounder
- VIIRS – Visible Infrared Imaging Radiometer Suite
- CrIS – Cross-track Infrared Sounder

Alternate Method



➤ ATMS – Advanced Technology Microwave Sounder

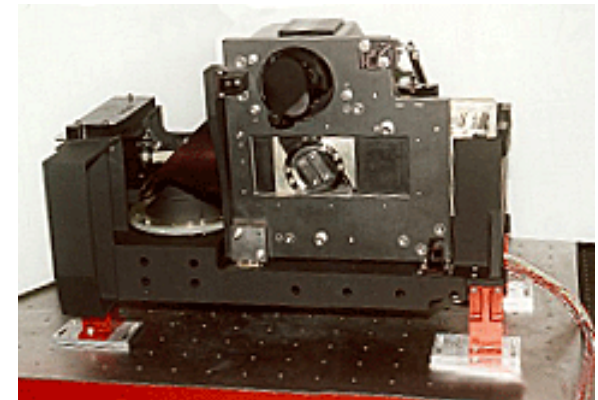
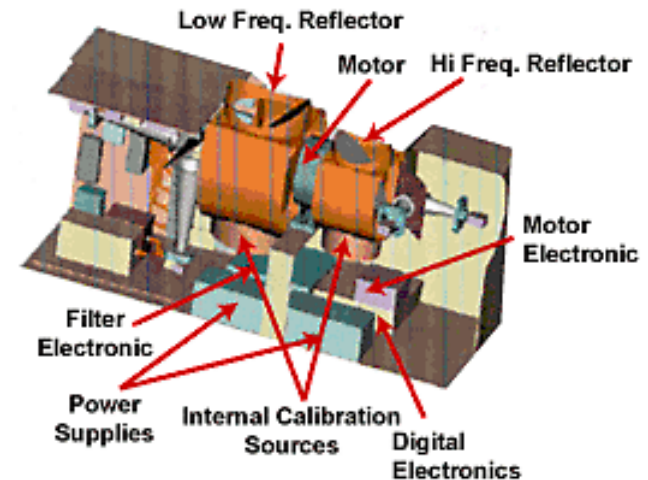
- Ten altitude bands, from 4 to 37 Km
- Measures water vapor and temperature
- 32 Km spot size

➤ CrIS – Cross-track Infrared Sounder

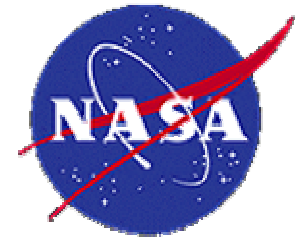
- Measures water vapor, temperature and pressure

➤ VIIRS – Visible Infrared Imaging Radiometer Suite

- Measures temperature and pressure



Summary



- NASA FAA NOAA Industry Collaborative Effort
- TAMDAR Sensor Development
- Ground/Flight Testing
- FAA Capstone
- NOAA FSL
- WINCOMM Datalink Evaluation
- Fleet Operational Evaluation
- AWIN National Demonstration